GROUNDWATER INFORMATION SHEET

Perfluorooctanoic Acid (PFOA) & Related Compounds

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The information provided herein relates to wells (groundwater sources) used for public drinking water, not water served at the tap.

GENERAL INFORMATION	
Constituent of Concern	Perfluorooctanoic acid (PFOA)
Aliases	C8, perfluorooctanoate, pentadecafluorooctanoic acid, perfluorocaprylic acid, FC-143, F-n-octanoic acid, PFO
Chemical Formula	$C_8HF_{15}O_2$
CAS No.	335-67-1
Storet No.	Not Available
Related Compounds	Perfluorooctane sulfonate (PFOS), Perfluorononanoic acid (PFNA), Perfluorooctanesulfonamide (PFOSA), and numerous other fluorinated telomers.
Summary	Perfluorooctanoic acid (PFOA) and related compounds have been identified as chemicals of emerging concern (CECs). These synthetic compounds are very persistent in the environment, are found at low levels in the environment and in the blood of the general US population, will remain in people for a long time, and have been found to cause developmental and other adverse effects in laboratory animals. Under an agreement with the US Environmental Protection Agency (US EPA) and eight manufacturers, PFOA was eliminated from emissions and products by the end of 2015. PFOS production was phased out by the 3M Company in 2002. The State of California does not have regulatory standards associated with PFOA or PFOS in drinking water. California has tested drinking water supplies for PFOA, PFOS, and related chemicals since 2013 as required by EPA under the third Unregulated Contaminant Monitoring Rule (UCMR 3). The results are published on the EPA health advisory website referenced below.

REGULATORY AND WATER QUALITY LEVELS

The US EPA has established a lifetime Health Advisory Level (HAL) for PFOA and PFOS of 0.070 micrograms per liter (µg/L) or 70 parts per trillion. When both PFOA and PFOS are found in drinking water, the combined concentrations of PFOA and PFOS should be compared with the 70 parts per trillion HAL.

Several states have passed groundwater quality regulations for PFOA. In West Virginia, residents must be provided with alternative drinking water when PFOA levels exceed 0.5 parts per billion (ppb, or 0.5 ug/L), which may have been update to 0.4 µg/L, following EPA's order vs. DuPont. Minnesota has adopted a Chronic Health Risk Limit of 0.3 µg/L for PFOA and PFOS in drinking water. New Jersey has established a preliminary health-based guidance of 0.04 µg/L for PFOA in drinking water.

Others (Schriks et al., 2009):

ADI/TDI – Acceptable/Tolerable Daily Intake: PFOA- 1.5 µg/kg/day, PFOS- 0.15 µg/kg/day

Other health based advisory or guideline levels can be found in literature but a complete list is beyond the scope of this fact sheet.

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS

In 2012, US EPA revised the UCMR 3 to establish a new set of unregulated contaminants. Assessment monitoring (List 1 Contaminants) was required for all Public Water Systems (PWS) serving more than 10,000 people and for 800 representative PWSs serving 10,000 or fewer people. Assessment monitoring was required of each PWS during a 12-month period from January 2013 – December 2015. PFOA, PFOS, and related chemicals are included on the List 1 Contaminants. The results are published on the EPA web site.

In California, PFOA and related compounds were analyzed in public drinking water systems from 2013 to 2015 under UCMR 3. Information regarding the distribution and detections of PFOA and related compounds in public drinking water sources are available at the EPA UCMR 3 website referenced below.

ANALYTICAL INFORMATION

Powerful analytical methods such as LC-MS-ESI (liquid chromatography-mass spectrometry-electrospray ionization) are capable of detecting PFOA and PFOS at the nanograms per liter (ng/L), or parts per trillion (ppt) levels. For the UCMR 3 monitoring program, a LC/MS/MC-EPA Method 537 was required with minimum reporting levels (MRL) of 0.02 µg/L and 0.04 µg/L for PFOA and PFOS, respectively.

OCCURRENCE	
Anthropogenic Sources	PFOA is a manufactured compound and is used as a surfactant and emulsifier in a variety of products. It is used to make fluoropolymers, substances that impart valuable properties such as fire resistance and oil and water repellency. Fluoropolymers are used to provide non-stick surfaces on cookware and to provide waterproof membranes for clothing. Products made from fluoropolymers include Teflon and Gore-Tex. Additional uses of fluoropolymers include carpet stain guards, fire-fighting foams, paints, cleaning products, paper coatings, and engineering coatings used in industrial manufacturing. Products made from fluoropolymers have been shown to contain trace quantities of PFOA. PFOA can also form as a degradation byproduct from other types of perfluorinated compounds (PFCs). PFOA is used as a surfactant and emulsifier in compounds used to coat a variety of food packages. Trace levels of PFOA have been observed in food that is packaged in these materials, including microwave popcorn bags. Perfluorooctyl sulfonates (PFOS), a related compound similar to PFOA, was widely detected in the blood of the general population in the 1990s. 3M, the manufacturer of PFOS, no longer produces this chemical.
Natural Sources	PFOA and related compounds are human made substances and are not naturally found in the environment.
History of Occurrence	Historically, both 3M and the DuPont corporations were the major producers of PFOA. The 3M corporation began manufacturing PFOA in the 1940s. DuPont began using PFOA in the 1950s. In 2000, 3M began phasing out production of PFOA and related compounds. Because of it, DuPont built its own PFOA manufacturing plant in 2002 in North Carolina. DuPont and 8 other manufacturers have, in an agreement with the US EPA, indicated they have ceased emissions and eliminated PFOA in products by the end of 2015. EPA has an opportunity to review any effort to reintroduce the chemical into the market place under the proposed Toxic Substance Control Act's Significant New Use Rule (SNUR). Due to the chemical structure, PFOA is extremely stable and very long lived. It has been characterized as "virtually indestructible" in nature, and does not degrade from heat, light, or microbial action.

Contaminant Transport Characteristics	PFOA is a surfactant and as a result has both a hydrophilic and hydrophobic end. These characteristics allow PFOA to easily dissolve in water. PFOA has been detected in groundwater at several sites in the United States, most frequently in locations associated with manufacturing and disposal of PFOA and related compounds. Although the half-life of PFOA in the atmosphere is 90 days, the half-life in water is over 92 years. It is very stable and found in every possible environment around the globe.

REMEDIATION & TREATMENT TECHNOLOGIES

PFOA is long-lived and does not degrade in groundwater. Every molecule of PFOA produced will persist indefinitely; incineration is required for complete PFOA destruction. However, reverse osmosis, nano-filtration, and activated charcoal are effective in removing PFOA from water. Anionic resins are being tested with a groundwater pump and treatment system at a landfill in Minnesota.

Recent evidence suggests that a number of degradation techniques may be effective in destroying fluorochemicals. These methods include photocatalytic oxidation, photochemical oxidation, photochemical reduction, thermally-induced reduction, and sonochemical pyrolysis. The effectiveness of these methods depends upon the initial concentration of the constituent, background water chemistry, and degradation time.

HEALTH EFFECT INFORMATION

Studies indicate that continued exposure to low levels of PFOA in drinking water may result in adverse health effects. Depending on the study, PFOA and PFOS have half-lives in humans ranging from 2 to 9 years.

Acute and intermediate-duration oral studies on rodents have raised concerns about potential developmental, reproductive and other systemic effects of PFOS and PFOA. The ingestion of PFOA-contaminated water was found to cause adverse effects on mammary gland development in mice. One study indicated that exposure to PFOS can affect the neuroendocrine system in rats; however, the mechanism by which PFOS affects brain neurotransmitters is still unclear.

In May 2006, the EPA Science Advisory Board suggested that PFOA cancer data are consistent with the EPA guidelines for the Carcinogen Risk Assessment descriptor “likely to be carcinogenic to humans.” EPA is still evaluating this information and additional research pertaining to the carcinogenicity of PFOA.

The animal studies also showed reduced birth size, physical developmental delays, endocrine disruption, and neonatal mortality.

In December of 2009, California’s Office of Environmental Health Hazard Assessment (OEHHA) prioritized PFOA and related salts, transformation, and degradation products for possible listing under Proposition 65. Listing under Proposition 65 would require manufacturers to disclose the presence of PFOA as a potentially carcinogenic compound in materials in which PFOA and related compounds were present.

In August, 2015 the OEHHA proposed that PFOA and PFOS were reviewed by the Developmental and Reproductive Toxicant Identification Committee (DARTIC) under Proposition 65. These chemicals were not proposed for listing during that time and OEHHA is seeking public comments and the DARTIC consultation regarding if the chemicals should proceed to the next stage of the listing process.

KEY REFERENCES

1. California State Water Resources Control Board, Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water, Appendix J, Summary of Drinking Water Benchmarks for CECs, http://ftp.sccwrp.org/pub/download/DOCUMENTS/CECpanel/CECMonitoringInCARecycledWater_FinalReport.pdf

2. OECD Environment Directorate, Environment, Health and Safety Division, Synthesis Paper on Per- and Polyfluorinated Chemicals (PFCS) http://www.oecd.org/env/ehs/risk-management/PFC_FINAL-Web.pdf

3. Office of Environmental Health Hazard Assessment, Prioritization: Chemicals For Consultation By The Developmental and Reproductive Toxicant Identification Committee http://oehha.ca.gov/prop65/CRNR_notices/082815DARTprioritization.html

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